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**RESEARCH NOTE**

# DOES THE FRAGMENTED AND LOGGED-OVER FOREST SHOW A REAL HYPERDYNAMISM ON BRACONID SPECIES?

YAAKOP, S.* and AMAN, A.Z.

*School of Environmental and Natural Resource Sciences,*
*Faculty of Science and Technology,*
*Universiti Kebangsaan Malaysia,*
*Bangi, 43600 Selangor*
**E-mail: salmah78@ukm.my*
*Phone: +603 89215698*

Does the Bangi Forest Reserve (HSB), located in Selangor, Malaysia show a real hyperdynamism on the braconid species? Many ecologists would agree that this is a tough question to answer. Hyperdynamism can be defined as an increase in the frequency and or amplitude of population, community and landscape dynamics in fragmented habitats (Laurance 2002). Hyperdynamism alter and affects the richness and abundance of the flora and fauna in a fragmented forest. Fragmentation results in the creation of large areas of the forests that becoming susceptible to the edge effects (Broadbent *et al.,* 2008). HSB is as a secondary lowland dipterocarp forest and lies between 2º54'N and 101º4.5'E in the district of Hulu Langat, Selangor. It is flat forest with several patches of swamps and small streams. The altitude of HSB is between 40-110 m and the highest peak is Bukit Rupa (110 m a.s.l). To answer the question that was raised above, a total of five malaise traps have been placed in Bukit Rupa to intercept the braconid species for half a year (March-July 2102).

HSB is not a popular investigation and exploration area among many naturalists, locally and internationally. This is probably due to its status as a logged-over forest, where it has been logged twice between 1941-1945 and 1968 (Mat Salleh, 1999; Noraini, 1990). Additionally, researchers are not interested because of the unstable condition of the forest as a result of the ongoing changes in the function of the tropical forest's ecosystem (Schleuning *et al.,* 2011). Even though HSB has been gazetted as a green university research area, the surrounding areas are still being clear aggressively by physical or infrastructural development. Despite the many development that being done in adjacent area, several diversity and systematic studies on birds, plants, dragonflies, braconids and other have been carried out to measure the status of the forest and the species in the community since 1997 (Choong *et al.,* 2008; Idris *et al.,* 2002; Idris and Hasmawati 2002; Mat Salleh, 1999; Zubaid *et al.,* 1997). Generally, the past logging process affects the insect's biodiversity due to the environmental changes (Schleuning *et al.,* 2011; Jiménez-Peydró and Peris-Felipo, 2011). Therefore, the best and effective indicator which can indicate the changes occur in the study area must be selected to measure the current forest status. At this point, insects are recognized as the best indicators to be exploiting because of their speedy and dramatic response to the ecosystem changes (Chung *et al.,* 2000). Therefore, braconids are among the best species to be used as an ecosystem indicator as they play an important role as parasitoids or biological control agents (Fielder and Landis, 2007a, b) by parasitize their hosts and finally killing them (Godfray, 1994; Hochberg and Ives 2000). Braconid also has narrow range of host and high degree of specialization which make them as a sensitive indicators in the environment (Shaw and and Huddleston 1991). There are several subfamilies of Braconidae that have been potentially proven as a biological indicator of environmental changes or health status. As a result, various species of these groups have been introduced as highly successful agents of classical and novel association biological control of lepidopteran pests (Waage and Hassell, 1982; Stiling and Cornelissen, 2005).

HSB is a habitat of few endemic species of flora and fauna from Peninsular Malaysia. The Bertam (*Eugeissona tristis*) and particularly the Black Hornbill (*Anthracoceros malayanus*) which is classified as Near Threatened on the IUCN Red List

* To whom correspondence should be addressed.

has been found in HSB. Several interesting species that also inhabit HSB such as the Japanese Sparrow hawk (*Accipiter gularis*), the smallest dragonfly, Scarlet Dwarf (*Nannophya pygmaea*), Malayan Colugo or flying lemur and Banded Leaf monkeys (*Galeopterus variegates*). All of these informations are very useful as a preliminary data to manage and conserve the flora and fauna of the forest before going extinct. Thus, a fundamental study on diversity is compulsory for conserving and managing their genetic resources.

One of the most important parameters to measure the extent of the hyperdynamism severity is by estimating the number of extinct, rare and endemic species (MacAuthor and Wilson, 1967, Wahlberg *et al.,* 1996; Fahring, 1997; Laurance, 2002). Therefore, the selection of braconid is one of the best techniques. However, due to lack of taxonomical studies have been done on the braconids species from Malaysia, the status of extinct, rare and endemic could not be confirmed to determine the current status of HSB. Therefore, determining the hosts of braconid species and the host's food is one of the effective ways to highlight the endemic braconid species from HSB. However, further taxonomical study with additional molecular data would help in confirming the status of the braconid species. The fragmented and isolated logged-over forests are the main drivers that affect the biodiversity of species in the ecosystem (Leidner *et al.,* 2010). In this study, there is no record of braconid species listed as an extinct, rare or endangered species, even though several singleton species of braconids were collected (Fernandez-Triana *et al.,* 2011; Lewis and Whitfield, 1999). However the result may be biased due to the short-term sampling duration. Therefore, a long-term sampling is compulsory and strictly needed to give the best figure of the real situation. Leidner *et al.* (2010) have mentioned and discussed in their paper that 11 years of data are highly necessary to conclude and summarize the effects of fragmentation on changes in species richness and composition of the community through times. The study on spatial and temporal variability of braconid species has also been discussed based on the influence of fragmentation and its significance with long-term sampling duration (Brückmann *et al.,* 2011).

In this paper, we analyzed the diversity of braconids to estimate the whole ecosystem of the HSB, in terms of whether it has shown some degree of hyperdynamism. The results of the analysis based on the Shannon Diversity Index (H'), Evenness Index (E), and Richness Index (R') were 3.46, 0.96 and 9.07, respectively. Braconids were identified to the morphospecies and the diversity indices were compared with the other localities that differ in the habitat types, namely Lata Jarum Reserve Forest (LJRF) and Endau-Rompin, Selai, Johor National Park (ERNP) (Table 1 & 2). Both locations are primary reserve lowland dipterocarp forests and not classified as fragmented or logged-over forest. Furthermore, the recent record of braconids in HSB has also compared with previous diversity studies back in 2002 (Idris *et al.,* 2002; Idris and Hazmawati, 2002). Due to the limitation of raw data, the diversity of braconids in HSB only emphasize on the subfamily of Microgastrinae.

From the previous studies by Idris *et al.* (2002) and Idris and Shahliney (2005), the diversity indices of HSB were 3.94 and 3.27, respectively. These studies showed that since 2002, the diversity of braconid species had seriously declined. This might due to the various construction projects that were carried out and are still ongoing in the surrounding area of HSB, which has encouraged hyperdynamism. Nowadays, the surrounding area is a fully developed area with the construction of the Malaysian Institute for Nuclear Technology Research (MINT), Malaysia Genome Institute (GENOME), the clearance of oil palm plantations and areas for housing.

In this study, a total of 14 subfamilies were collected from HSB, namely Agathidinae, Alysiinae, Blacinae, Braconinae, Cheloninae, Doryctinae, Euphorinae, Lysiteriminae, Microgastrinae, Opiinae, Orgilinae, Pambolinae, Roganinae and Xiphozelinae. These subfamilies are common particularly in Malaysia, and have also been collected in other localities which have different types of forests (Fitri-unpublished; Idris and Shahlinney, 2005). A total of six genera, namely *Asobara* Foerster, *Aspilota* Foerster, *Dinotrema* Foerster, *Cratospila* Foerster, *Phaenocarpa* Foerster and *Diachasmimorpha* Viereck, consisting of seven species of Alysiinae and Opiinae have been identified. These species are commonly found in the other forest types in Malaysia. Intensive taxonomic revision on Braconidae from the Oriental region is highly recommended in the near future to provide enough data on the endangered or rare species, as well as endemic species. Braconids have been determined as poor fliers (Lewis and Whitfield, 1999), producing many offspring in one host and having a short life cycle (Matthews, 1974). The braconid experts from the National Centre of Biodiversity, Naturalis, The Netherlands said that there are many endemic, rare or endangered species of Braconidae from the tropical region if intensive revision on that family is carried out intensively (pers. com. van Achterberg). However, there were no endemic, rare, extinct or endangered braconid species found from HSB in this study, and this is probably due to the limitation of the sampling period.

**Table 1.** Comparison of Shannon Diversity Index (H') values for the Braconidae species in several localities. Values of H' with similar letters are not significantly different (P > 0.05)

| Sampling sites | Diversity Index (H') | Evenness Index (E) | Richness Index (R') |
|---|---|---|---|
| Bangi Reserve Forest, Selangor (HSB), Malaysia | 3.46[a] | 0.94 | 9.07 |
| Lata Jarum Reserve Forest, Pahang (LJRF), Malaysia | 3.35[a] | 0.92 | 7.5 |
| Endau- Rompin, Selai, Johor Natural Park (ERNP), Malaysia | 3.15[a] | 0.90 | 7.85 |

**Table 2**. The Diversity Index (H'), Evenness Index (E) and Richness Index (R') of the Microgastrinae collected from several sampling sites. There is no significant difference between the sampling sites for value H'

| Sampling sites | Diversity Index (H') | Evenness Index (E) | Richness Index (R') |
|---|---|---|---|
| Bangi Reserve Forest, Selangor, Malaysia | 1.90 | 0.98 | 1.8 |
| Bangi Reserve Forest, Selangor, Malaysia (data observed in 2002) | 1.06 | 0.54 | 1.33 |
| Lata Jarum Reserve Forest, Pahang, Malaysia | 1.71 | 0.88 | 1.56 |
| Endau-Rompin, Selai, Johor Natural Park, Malaysia | 1.33 | 0.83 | 1.28 |

Our results showed that there were no significant difference (df= 103, t= 2.388, p > 0.05) and (df= 154.4, t= 1.2, p > 0.05) on the braconids diversity between HSB (3.46) with Endau-Rompin, Selai, Johor Natural Park (ERNP) (3.15) and Lata Jarum Reserve Forest (LJRF), Pahang (3.35), respectively. ERNP and LJRF are categorized as non-fragmented forests and still unexplored, while only some part has been visited by man. ERNP and LJRF are categorized as intact forests which most probably no hyperdynamism has occurred (Didham *et al.,* 1996). In addition, the Richness Index (R') of HSB, LJRF and ERNP are differed, where HSB being fragmented and logged-over forest with the highest value of R' (9.07), while ERNP (7.85) and LJRF (7.50) as non-fragmented forests. Therefore, we have proven that the fragmented forest always show a higher value of hyperdynamism as has shown in HSB compared to the intact forest ERNP and LJRF. It is because the Shannon-Diversity Index (H') of the braconid species did not show any significant difference between fragmented and the intact forests (Table 1).

Lewis and Whittfied (2010) mentioned that the degree of disturbance also affects the density of the braconid wasp population. In this situation, the fragmented forest shows hyperdynamism by revealing high density or abundance and richness of species. It might be due to the open area covered with weeds and flowering plants caused by the fragmentation that welcomed many braconid species as pollinators as they were attracted to the high density of the food sources.

In general, diversity of braconids constantly records the Miscogastrinae as the hyperdiverse subfamily with the highest number of individuals collected. The question on why Microgastrinae is the most abundant subfamily arises? It might be explained by the fact that the subfamily Microgastrinae is known as exclusive caterpillar parasitoids that play an important economically role in the world as a pest biocontrol agent of Lepidoptera (Whitfield, 1997). However, the number of species (richness) was also more or less similar and did not show any significant difference between the HSB and the other locations (Table 2). Hence, this issue contradicts the concept of hyperdynamism in which richness and abundance is reported to be always high in a disturbed area. Most probably, the measurement of hyperdynamism must be done by counting all the families of the Braconidae to get a better picture of the situation, not only emphasizing on one subfamily of Braconidae.

Therefore, we conclude that hyperdynamism has occurred in the HSB, with no exception for any species, especially braconids species. However, no record of endemic, rare and endangered species has been documented for braconids in this study. Again, why is there an exception for the braconid species? The question probably cannot be answered at this moment. However, a long-term research needs to be done to get a clear and better picture of this situation. At the moment, continuous sampling probably two years duration with additional work of a taxonomic study on the braconid species is carry out. The outcome from the diversity and

taxonomy study is hope to reveal more information so the better understanding and confident answers can be provided on what species are endemic, rare and endangered in the fragmented and logged-over forest, especially in HSB.

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